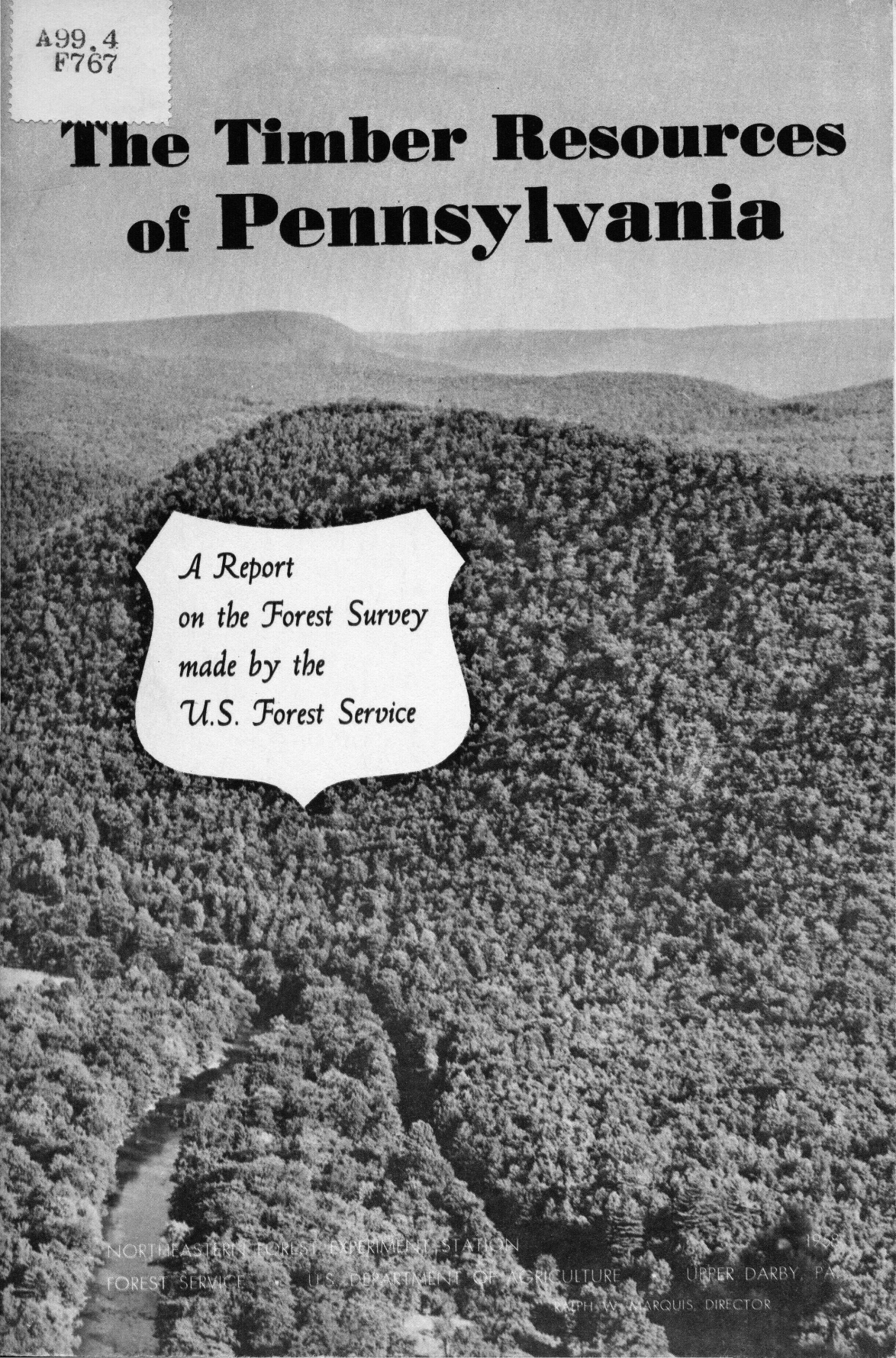
The Timber Resources of Pennsylvania



A Report on the Forest Survey made by the U.S. Forest Service

NORTHEASTERN FOREST EXPERIMENT STATION
FOREST SERVICE — U.S. DEPARTMENT OF AGRICULTURE
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Preface

THIS is a report on the timber resources of Pennsylvania. It is based on the findings of a survey made by the Forest Service, U.S. Department of Agriculture, as part of a nationwide forest appraisal. The survey data show--as of January 1, 1955--the area and condition of the forest land, and the volume and quality of the standing timber. They also include, for the year 1954, estimates of timber growth and mortality, and estimates of timber cut for forest products. The forest survey was conducted over a 5-year period, 1949-54.

This is not, of course, the first forest survey made in Pennsylvania. In 1926, the Pennsylvania Department of Forests and Waters made a county-by-county estimate of the state's forest area. Since then, other appraisals of forest area and timber volume have been made. However, the definitions, standards, and procedures used have varied so much that comparison of earlier estimates with the data in this report will hardly even indicate trends.

This forest survey report supersedes a series of eight preliminary reports, based on the same survey, which were published for the main geographical sections of Pennsylvania a few years ago. Each of these reports gave forest areas and timber volumes for groups of counties, but the dates of the estimates varied from section to section. To make all the data comparable for this report, timber-volume statistics have been adjusted to a common date. Forest-area estimates, however, have not been changed.

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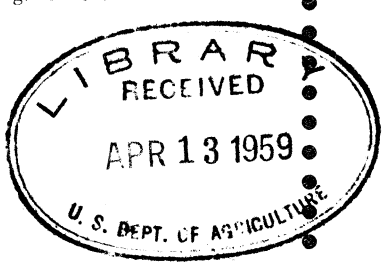

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Pennsylvania.

The very name of it--Penn's woods--smacks of forest. The importance of the timber on this land was recognized at the Commonwealth's beginning, when William Penn received the land from Charles II of England as payment for a debt. In 1681, Penn wrote in the Charter of Rights that he gave to his colonists "...that in clearing the ground care be taken to leave one acre of trees for every five acres cleared..." At that time, most of the land was covered by virgin forests --high-quality stands of white pine, hemlock, oaks, maple, beech, and other hardwoods.

Today--despite 300 years of hard usage--Pennsylvania still has 15 million acres of forest land, slightly more than half of the state's total land area. But how well does this forest resource fill the needs of today? And how well will it serve the economy of the future?

In an attempt to provide answers to these questions, the U.S. Forest Service has made a survey of the forest land in Pennsylvania. This is a report on that survey.

Use of the Timber Resource

THOUGH the forest survey of Pennsylvania was concerned mainly with timber and the use of the forests as a source of raw material, one must consider that a forest resource provides many benefits besides raw material. The value of a forest resource is also measured in terms of water supply, recreation, and wildlife.

The large population and big industries in Pennsylvania use enormous quantities of water, more than 7 billion gallons daily.[1] Only three other eastern states consume more. Forested watersheds help to stabilize the flow of water throughout the year by storing water when it is abundant and releasing it gradually. Forests also protect watersheds from erosion, reduce danger of floods, and prevent rapid sedimentation of streams and reservoirs.

Campers, hikers, and picnickers seek enjoyment in the 80,000 acres of woodland in State Parks and Forest Monuments. Sportsmen hunt deer, bear, and small game on the more than 800,000 acres of multiple-use State Game Lands. It has been estimated that one of every five persons in the Middle Atlantic region (Pennsylvania, New York, and New Jersey) 12 years old and older hunts or fishes.[2] From that, one can estimate that 1,700,000 Pennsylvanians hunt or fish. These sportsmen spend some $195,000,000 annually for equipment, licenses, travel, and other expenses.

The Lumber Industry

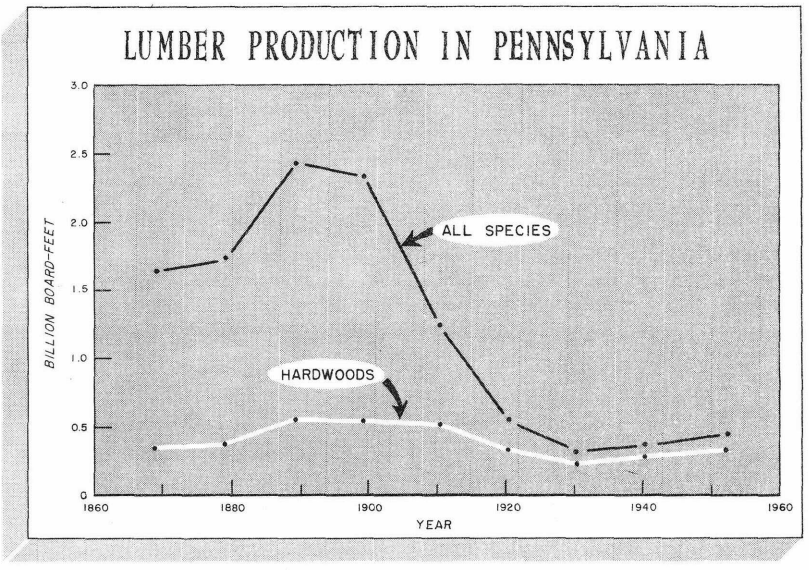
Pennsylvania has had a long and colorful history in lumbering. By 1860 Pennsylvania had topped all other states in lumber production. The Census of 1859 reported that

[1] Bello, Francis. How are we fixed for water? Fortune 49 (3): 120-135, illus. 1954.

[2] Fish and Wildlife Service. National survey of fishing and hunting. U. S. Dept. Interior Circ. 44. 50 pp., illus. 1956.

Pennsylvania sawmills produced $10,700,000 worth of lumber, topping second-ranked New York by a million dollars. The next Census, in 1869, gave some idea of volume: Pennsylvania produced 1.6 billion board-feet of lumber, one-eighth of the national total.

Lumbering reached its peak in Pennsylvania about 1890[3]. Over 2.3 billion board-feet were produced in the census years 1889 and 1899. By the turn of the century, the situation had changed, and Pennsylvania was importing lumber



Once the top lumber-producing state, Pennsylvania now imports more lumber than it produces. Since about 1915 the state has produced more hardwood lumber than softwood.

rather than exporting it. Between 1910 and 1920, the production of hardwood lumber exceeded that of softwood for the first time. And by 1922, some 84 percent of the lumber and about 74 percent of the pulpwood being used in the state came from outside.[4]

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[3]Steer, Henry B. Lumber production in the United States, 1799-1946. U. S. Dept. Agr. Misc. Pub. 669. 233 pp. 1948.

[4]Illick, Joseph S. The forest situation in Pennsylvania. Pa. Dept. Forests Bul. 30. 14 pp. 1923.

Now about three-fourths of all wood products consumed in Pennsylvania come from other states. In 1954, the timber stands of Pennsylvania provided a cut of approximately 154 million cubic feet. That year sawmills produced more than 496 million board-feet of lumber in Pennsylvania, now ranked 24th in the Nation for lumber output.

Ninety-six large sawmills, each sawing a million board-feet or more annually, produced over a fourth of this lumber. The rest was produced by 2,283 smaller mills that saw less than a million board-feet annually.

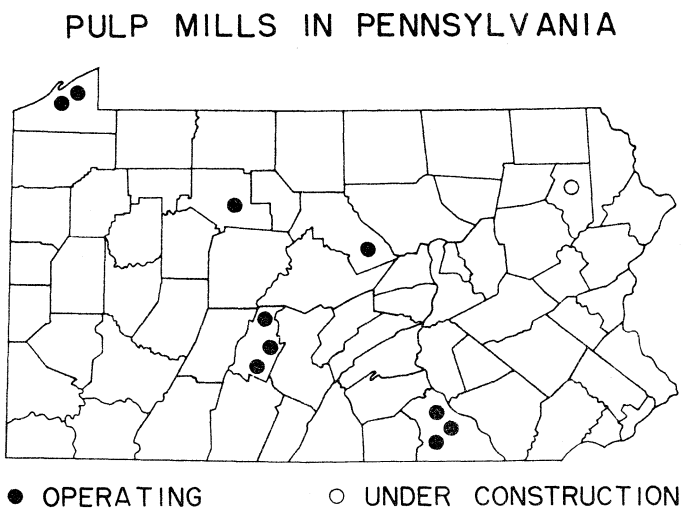
Timberland owners in Pennsylvania receive about $40 million annually for sawlogs and bolts delivered to sawmills or collection points. More than 66,000 people worked in the timber-based industries in Pennsylvania in 1954; they received about $240 million in salaries and wages. Manufacturing of wood into lumber, furniture and fixtures, and paper and allied products increased the value of the raw material by some $425 million.

The Pulpwood Industry

The pulpwood industry has become increasingly important in Pennsylvania. The ten pulp mills in the state consume two-thirds as much wood as the lumber industry. Four of these mills produce wood pulp by the sulphate process alone, while another uses only the semi-chemical process. The remaining five mills each employ two different processes. Four of these use the sulphite process and either the groundwood, soda, or semi-chemical processes. One mill utilizes the soda and semi-chemical processes.

From 1899 to 1927, Pennsylvania ranked among the first five states in pulpwood consumption and wood pulp production.[5] During this period, most wood pulp was produced mechanically. Output of wood pulp by chemical processes has increased rapidly since the 1920's; and other states, particularly in the South, have become major producers. Pennsylvania's wood pulp production dropped from

[5]Studley, James D. U. S. Pulp and Paper Industry. U. S. Dept. Com. Bur. Foreign and Domestic Com. Trade Promotion Ser. 182. 99 pp. 1938.



Location of the 10 pulp mills in Pennsylvania. The pulpwood industry has become increasingly important.

6.3 percent of national production in 1923 to 1.8 percent in 1952.

Pulp mills in Pennsylvania consumed about 443,000 cords of pulpwood in 1954. Of this, 316,000 cords came from the forests within the state, and 127,000 cords came from other states and Canada. Of the imported pulpwood, more than 40 percent was spruce and fir from Canada. At the same time, about 19,000 cords of Pennsylvania pulpwood was shipped to pulp mills in other states.

Other Forest Industries

Numbered among Pennsylvania's other wood industries are three independent veneer plants; two produce commercial veneers, the third, basket veneers. In 1954 these plants processed some 477,000,000 board-feet of veneer logs and bolts. Most of this volume, made up exclusively of hardwoods, came from local forests. Yellow-poplar alone comprised four-fifths of the total volume. Then too, 4,140,000 board feet of veneer logs were shipped to veneer plants outside the state.

Six cooperage plants in the state processed over 2 million board feet in 1954. Nearly all of this volume was locally produced white oak. Handle mills, shingle mills, bobbin mills, wood-turning plants, and charcoal producers together used nearly 3 million cubic feet, all hardwood.

Nonmanufactured Timber Products

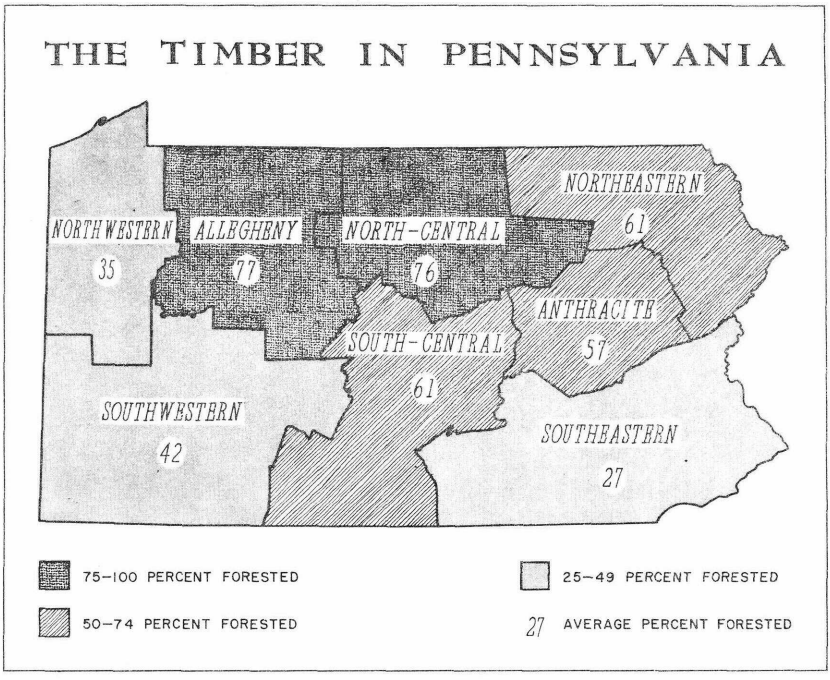
In addition to providing raw material for sawmills, pulp mills, and other forest industries, the forests of Pennsylvania also provide a variety of timber products that do not require any manufacture. These include mine timbers, posts, pilings, and fuelwood. About 12 million cubic feet of round mine timbers, all hardwood, and about 6½ million cubic feet of posts and piling, predominantly hardwood, were harvested in 1954.

The fuelwood cut in 1954 was over 578,000 cords. In addition, roughly 122,000 cords of mill residues were used for domestic and industrial fuel. About 462,000 cords of fuelwood were cut from hardwood limbs, cull trees, dead trees, and trees on noncommercial forest land and nonforest land. The remaining 116,000 cords were taken from commercial timber.

The Forests Today

MORE land area is used for forests in Pennsylvania today than for all other land uses combined. Fifteen million acres have some kind of forest cover (table 12),[6] the Forest Survey found; while about 9 million acres are used for agricultural purposes, according to the 1954 Census of Agriculture. Urban areas, rights-of-way, and other miscellaneous uses take up the other 5 million acres.

[6]All tables referred to will be found at the back of this report.



The most extensive forests in Pennsylvania are found in the Allegheny and North-Central sections, where forests cover more than 75 percent of the land area.

The most extensive forests are found in the Allegheny and North-Central sections of the state (table 13). Here forests cover more than 75 percent of the land. Thirty-four of the 67 counties in the state have 50 percent or more of their land area in forest (table 3):

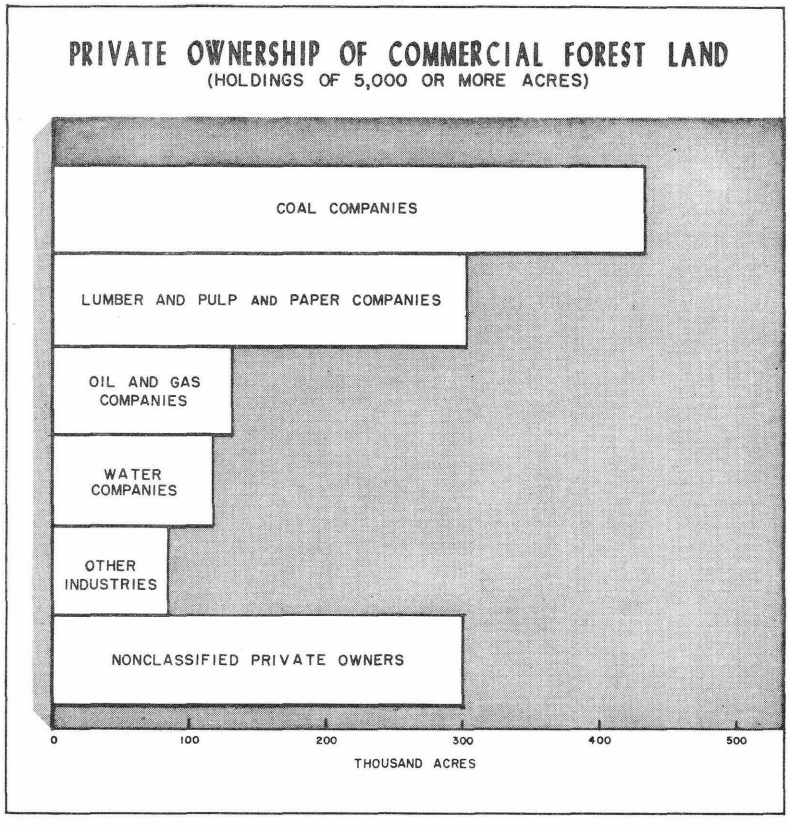
Counties (number)	*Percent forested*
9	75-95
25	50-74
23	25-49
10	1-24

Private Owners Hold The Most

Private holdings amount to 78 percent of the forest land in the state. The larger forest holdings belong to

forest industries, coal companies, natural gas and oil companies, water companies, railroads, and hunting and fishing clubs. But the bulk of the forest acreage belongs to small businessmen, laborers, professional men, clerks, housewives. All together, this diversified group of "other private" owners hold 8 million acres (54 percent) of the commercial forest land (table 15).

Farmers own more than 3 million acres, and forest industries own a little less than ½ million acres of commercial woodlands.



The larger forest properties belong to coal companies, lumber and paper companies, hunting and fishing clubs, and the like. But more than half of the private forest lands in Pennsylvania are in small holdings.

Nine out of ten private forest-land owners have holdings of 100 acres or less. These small holdings account for more than one-half of the privately owned commercial forest land. Most farm woodlands are among these holdings of 100 acres or less:

Size-class of holding (in acres)	*Number of owners*	*Thousand acres*
Less than 100	277,500	6,516
100 to 500	22,700	3,065
500 to 5,000	1,300	827
5,000 to 50,000	68	900
50,000 and over	6	475
Total	301,574	11,783

There are 74 private ownerships of 5,000 or more acres of commercial forest land, a total of 1.4 million acres. These larger owners include fifteen coal companies; they hold about 30 percent of the acreage in this class.

State Forests (1,799,000 acres), State Game Lands (839,000 acres), and other state holdings (21,000 acres) amount to 18 percent of the commercial forest land. Other public ownerships, principally the Allegheny National Forest, account for the remaining 4 percent of the commercial forest area.

One-Fourth Of The Forest Land Supports Sawtimber Stands

Sawtimber stands of 1,500 or more board-feet per acre occupy 27 percent of the commercial forest land (table 15). About 3 million acres carry stands of 1,500 to 5,000 board-feet per acre, with an average volume of 3,300 board-feet per acre. Sawtimber stands of 5,000 or more board-feet per acre occupy approximately 1 million acres and have an average volume of 7,500 board-feet per acre.

Because they contain the bulk of present timber supplies, sawtimber stands are of major importance to the forest industries. Present sawtimber volume is divided among the stand-size classes as follows:

Stand-size class	*Percent of volume*
Over 5,000 board-feet per acre	30
1,500 to 5,000 board-feet per acre	45
Under 1,500 board-feet per acre	25

Poletimber stands occupy almost one-half of the commercial forest land. Minimum net volume per acre for a poletimber stand is 200 cubic feet. The average volume per acre of all poletimber stands amounts to 750 cubic feet per acre.

Seedling and sapling stands and nonstocked areas cover one-fourth of the commercial forest land.

Nine Acres In Ten Are More Than 40 Percent Stocked

Stocking of trees on the land is not a serious problem in Pennsylvania. All but 1.2 million of the 15 million acres of forest land are 40 percent or more stocked.

Stocking in sawtimber stands consists of trees of all sizes, not just sawtimber trees. These stands may contain numerous trees of small diameters, of low value, and of poor quality. Further, poorly stocked stands (10 to 39 percent stocked) are not necessarily on poor sites; recent cutting or burning may be the cause of the poor stocking.

About ½ million acres (3 percent of the forest-land area) are less than 10 percent stocked. Some of these nonstocked and poorly stocked areas are being planted. By 1955, when almost 60,000 acres of land had been reforested, Pennsylvania ranked third in the Nation for total acreage planted.

Stand Quality Is Low

While stands made up largely of good quality sawtimber occupy 11 percent of the sawtimber area, 36 percent of the sawtimber area has no trees containing Grade 1 or Grade

2 sawlogs. Three stand-quality classes for sawtimber area were observed:

Stand-quality 1.--Stands in which 50 percent or more of the sawtimber trees contain Grade 1 and/or Grade 2 logs.

Stand-quality 2.--Stands in which 1 to 50 percent of the sawtimber trees contain Grade 1 and/or Grade 2 logs.

Stand-quality 3.--Stands in which there are no sawtimber trees containing Grade 1 and/or Grade 2 logs.

Slightly more than one-half of the stand-quality 1 area carries volumes of 5,000 or more board-feet per acre. On the other hand, very little of the area classified as stand-quality 3 supports heavier sawtimber stands.

Hardwood Forest Types Predominate

Forest stands in which hardwoods predominate cover 95 percent of the commercial forest land (table 16). Found in every county in the state, the red oak type alone covers one-third of the forest-land area. Sugar maple-beech-yellow birch, the next most prevalent type, occupies one-fourth of the total area. This type is found principally in the northern and southwestern part of the state. Other hardwood type areas, mainly chestnut oak and white oak, make up 35 percent of the total.

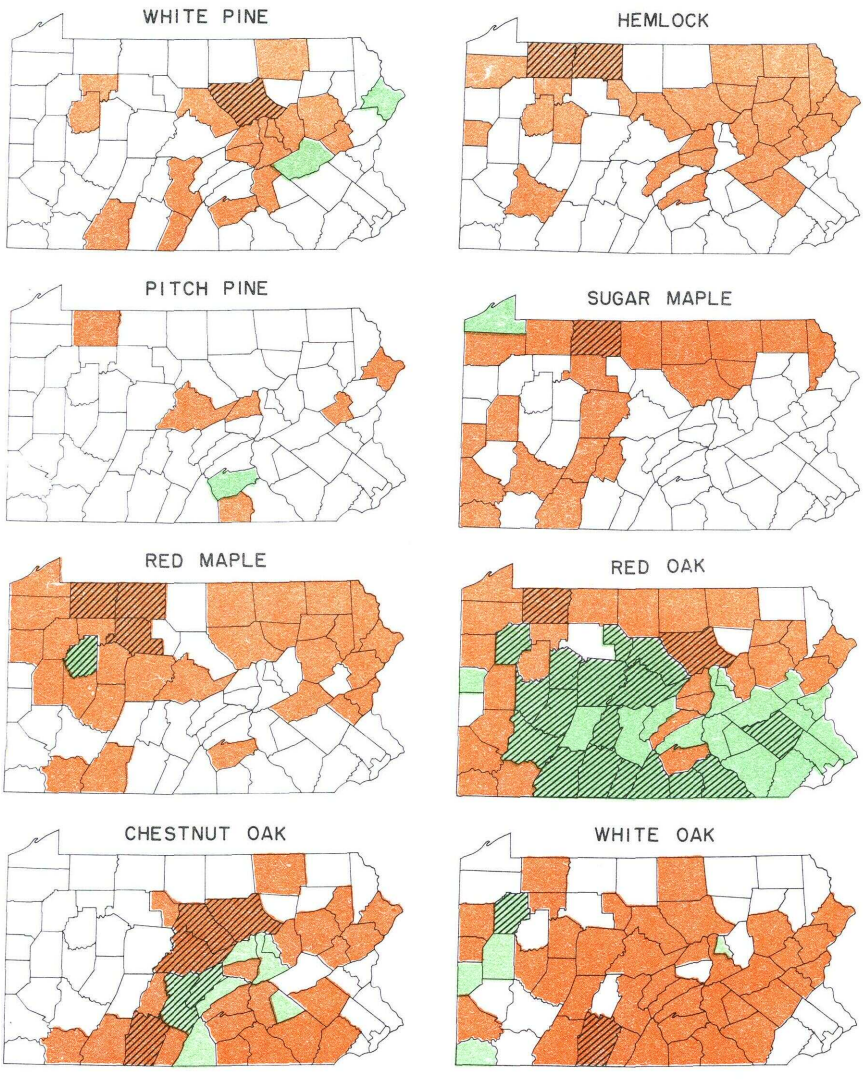
Softwood forest types, about equally divided between hemlock and pine types, occupy 5 percent of Pennsylvania's commercial forest land. In counties along the western boundary, softwoods are negligible, but elsewhere they occupy 5 to 10 percent of the forest area.

DISTRIBUTION OF SAWTIMBER

(BASED ON TOTAL BOARD-FOOT

LESS THAN 5% OF COUNTY TOTAL

5 TO 25% OF COUNTY TOTAL



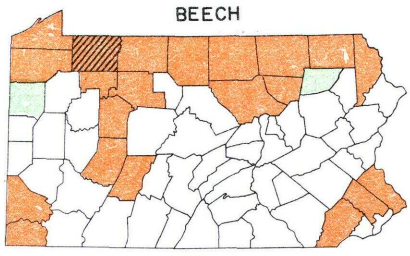
Distribution of sawtimber volume by species and county.

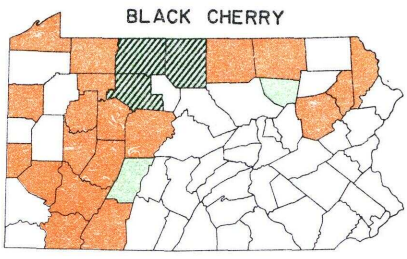
VOLUME BY SPECIES AND COUNTY

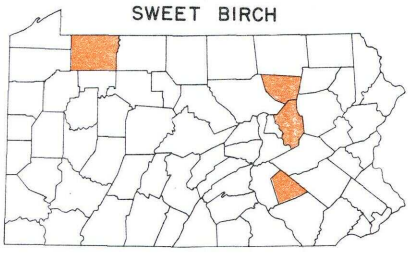
VOLUME IN COUNTY)

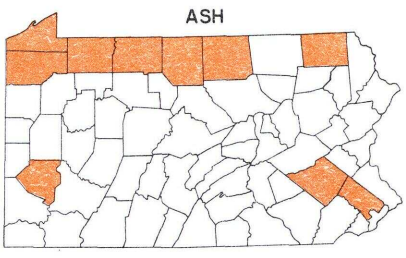
MORE THAN 25% OF COUNTY TOTAL

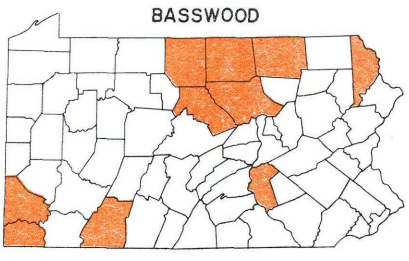
MORE THAN 100,000,000 BOARD-FEET

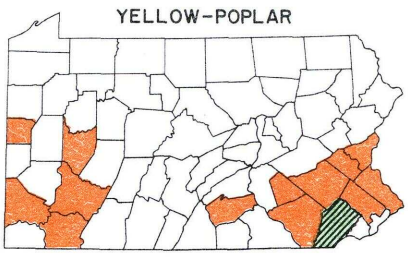


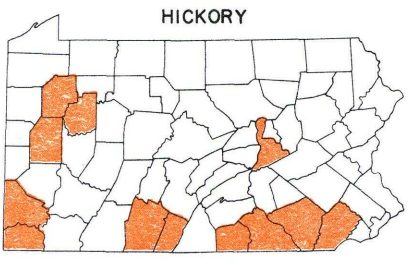


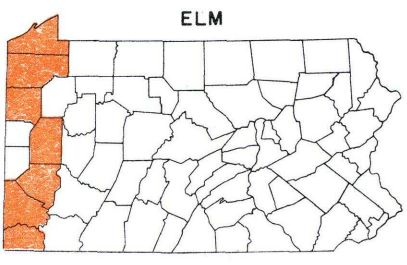












The Timber Supply

PENNSYLVANIA'S commercial forest land carries a total volume of 14.6 billion cubic feet (table 1) of sound wood.[7] Of this total volume, 12.1 billion is the net volume of growing stock; poletimber trees make up over half of it, sawtimber trees the rest. The other 2.5 billion cubic feet includes 1.1 billion cubic feet of hardwood limbs; 1.3 billion cubic feet in trees too limby, crooked, or defective to be used as sawtimber; and about 0.1 billion in noncommercial species such as pin cherry and hophornbeam. Although this cull material is not counted as growing stock, some of it is used, and it is a potential source of raw material for wood fiber.

Sawtimber Volume Adds Up To 23 Billion Board-Feet

Net sawlog volume of sawtimber trees amounts to almost 23 billion board-feet. Accounting for almost 23 percent of the total board-foot volume are red oaks, the state's most prevalent species. Only 7 out of the 67 counties in the state have less than 5 percent of their board-foot volume in the red oaks. Six other hardwoods--black cherry, chestnut oak, white oak, red maple, beech, and sugar maple--each accounts for more than 1 billion board-feet; together these six comprise 47 percent of the total board-foot volume (table 2).

Hemlock is the most important softwood species, comprising 6 percent of the total board-foot volume and one-half of the softwood board-foot volume.

More than 17 billion board-feet of sawtimber--three-fourths of the total--are found in sawtimber stands. Most

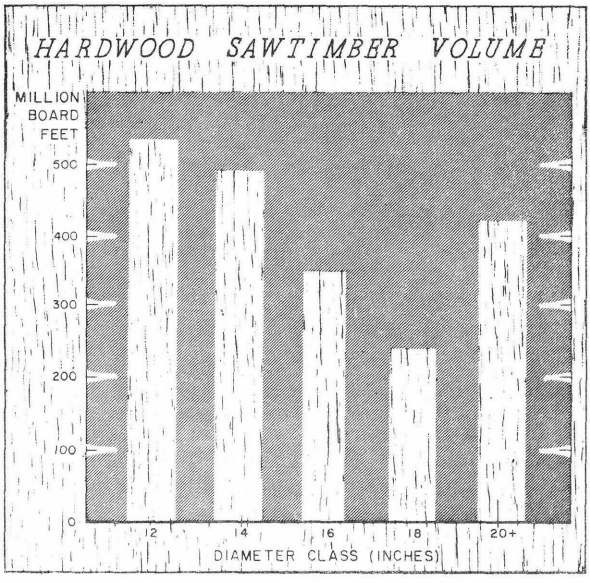
[7] This total does not include stumps, tree sections smaller than 4 inches in diameter and 4 feet long, and softwood limbs. See Appendix for definitions of terms.

of the remainder is scattered through poletimber stands (table 3).

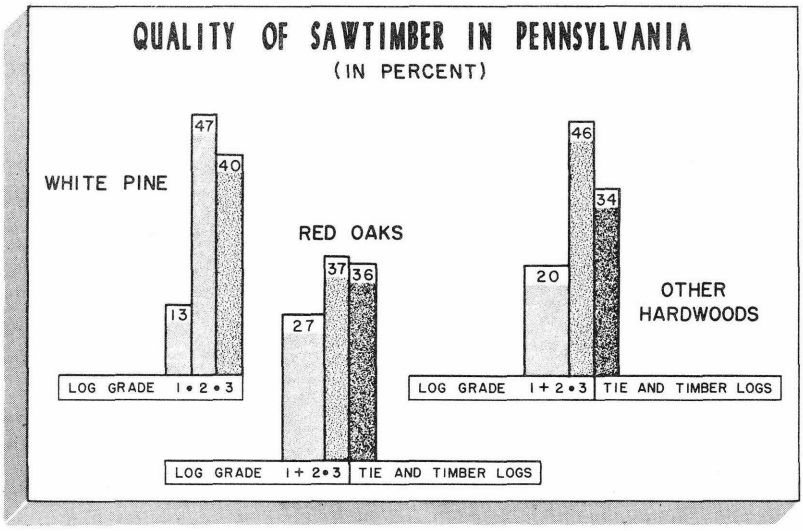
More than one-half of the board-foot volume in the state consists of trees less than 16 inches in diameter breast high (table 4). About 60 percent of the softwood sawtimber volume is in the 10- to 14-inch diameter classes. The hardwood sawtimber volume is about equally divided between the smaller diameter classes (12- and 14-inch) and the larger diameter classes (16-inch and above).

Quality Of Sawtimber Is Fair

Timber quality, as well as stand-size class and species, influences the amount of timber available to the lumber industry. Volume in the better grades of hardwood sawlogs--standard factory lumber log Grades No. 1 and No. 2--amounts to 4.4 billion board-feet and makes up 22 percent of the hardwood sawtimber volume. Grade No. 3 hardwood logs



More than half of the sawtimber volume is in the smaller size trees, softwood as well as hardwood.



The quality of sawtimber in Pennsylvania is fairly good, better than average for the Northeast as a whole.

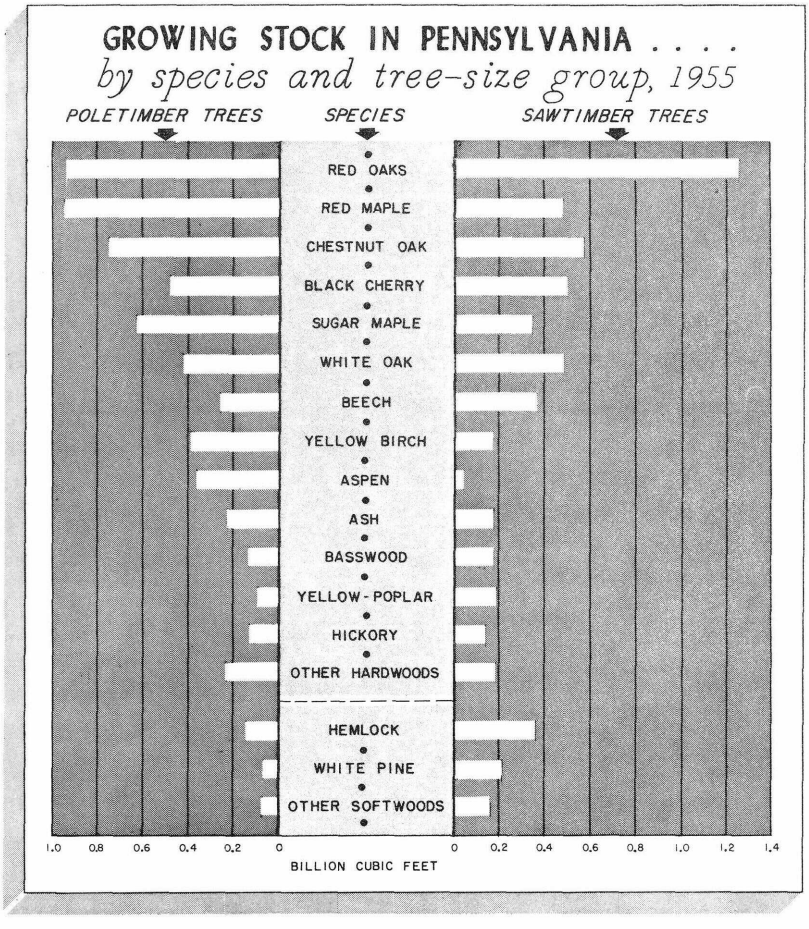
account for 43 percent, and the remaining 35 percent is composed of tie and timber logs (table 5).

Softwood sawlogs are graded on a different basis. Pine logs are classified according to three log grades; hemlock logs are divided into two classes--Grade 1 and all other. Most softwood sawlogs are of value to industry. About 60 percent of the white pine sawtimber volume occurs in the better grades.

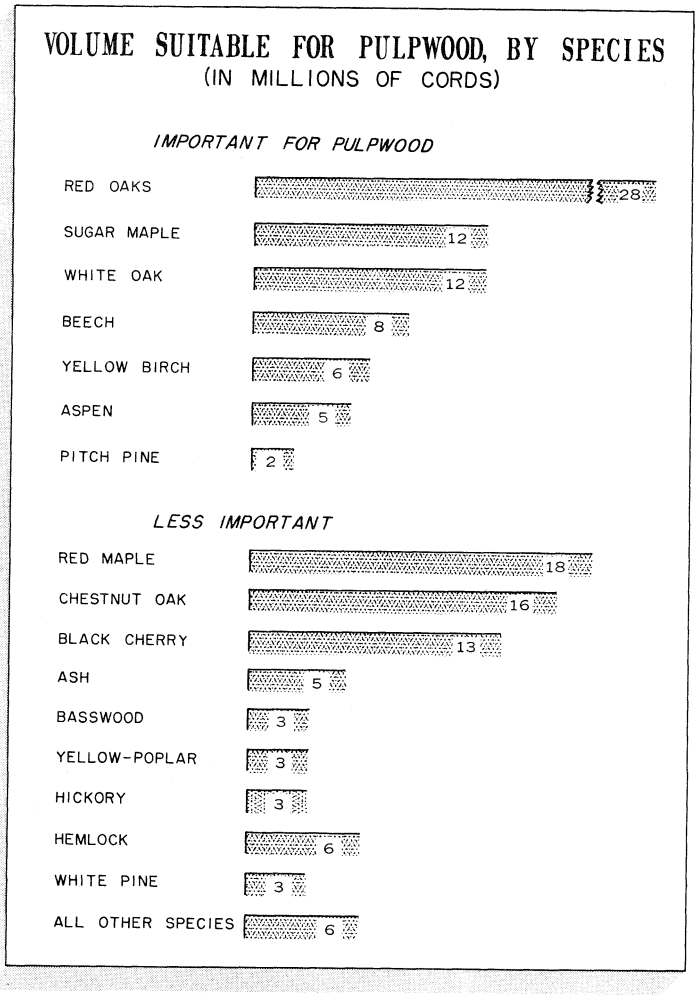
Growing Stock Amounts To 12.1 Billion Cubic Feet

Most growing stock--92 percent of the total--is hardwood, amounting to 11.1 billion cubic feet. Red oaks account for one-fifth of the hardwood volume. Red maple and chestnut oak are the next most common species, each having more than 1 billion cubic feet of growing stock.

Small trees make up the largest part of the timber volume. Over half the growing stock is made up of poletimber trees--hardwoods 6, 8, and 10 inches in diameter, and softwoods 6 and 8 inches. About 55 percent of the hardwood growing stock and 28 percent of the softwood growing stock is in trees of poletimber size.



Hardwoods make up most of the timber volume--92 percent. Red oaks alone account for a fifth of the hardwood volume.



A large volume of hardwood timber in Pennsylvania is suitable for pulpwood.

Volume Suitable For Pulpwood Totals 149 Million Cords

The volume of wood that meets the regional quality requirements of the pulpwood industry[8] amounts to about 149 million cords. This includes 141 million cords in growing-

[8]As developed by the Appalachian Technical Committee of the American Pulpwood Association.

stock trees (93 percent of the total growing stock) and 8 million cords in cull trees. Growing stock includes sawtimber trees, which account for about 60 million cords of wood suitable for pulpwood. It might be noted that all sound wood volume is not necessarily suitable for pulpwood. For example, the sound wood volume of a crotch in a tree's main stem, even though it was included in growing stock volume, is not included in the estimate of pulpwood volume.

Hardwood species represent about 91 percent of the volume suitable for pulpwood. In 1954, hardwoods constituted 83 percent of the growing stock cut for pulpwood. The state's principal pulpwood species are the red and white oaks, the northern hardwoods, aspen, and pitch pine.

Most trees suitable for pulpwood grow in stands sufficiently heavy to permit economical harvesting. One-half the total pulpwood volume is in stands of 15 cords or more per acre. These stands occupy 23 percent of the commercial forest land. And stands of 5 to 15 cords per acre, about 43 percent of the pulpwood volume, cover 42 percent of the commercial forest land:

Volume-per-acre class	*Thousand acres*	*Million cords*
Less than 5 cords per acre	5,283	10.6
5 to 15 cords per acre	6,386	63.6
More than 15 cords per acre	3,420	75.2
Total	15,089	149.4

Volume is Increasing

BEFORE the relationships between growth and cut are considered, the components of net annual growth and annual cut should be fully understood. The definition of growth begins with gross annual growth. This includes "ingrowth"--the volume of trees that reach poletimber or sawtimber size during the year. It also includes one-half

year's growth on trees cut or killed during the year. Then mortality--the entire volume of trees that died during the year--is deducted. The remainder is net annual growth. The estimate of timber cut includes the volume of logging residues that are not used, as well as the timber products output from sawtimber and poletimber trees on commercial forest land.

In Pennsylvania, gross annual growth of growing stock, including sawtimber trees, is about 677 million cubic feet (table 7). Of this, 70 percent is the growth on trees that were already at least 5 inches in diameter at the beginning of the year. Ingrowth (204 million cubic feet) accounts for the other 30 percent. Mortality comes to 96 million cubic feet. Deducting this from the gross annual growth leaves a net annual growth of 581 million cubic feet.

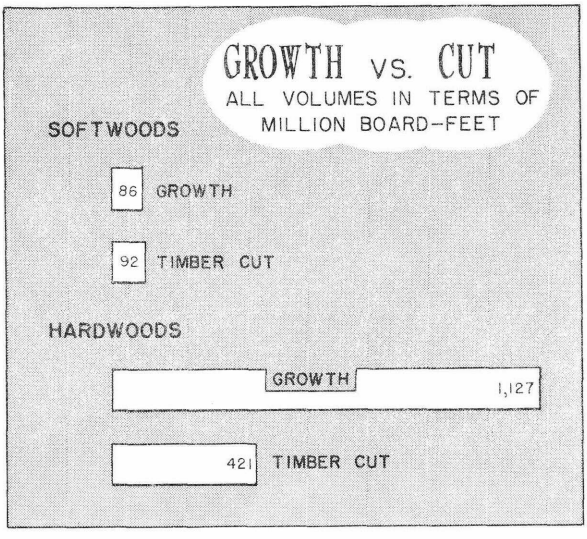
Net annual growth of sawtimber and poletimber trees suitable for pulpwood (in both growing stock and nongrowing stock) amounts to nearly ½ cord per acre per year. About 67 percent of this growth is in the "hard" hardwood species[9] such as oak, sugar maple, and beech:

Species group	*Annual growth (thousand cords)*
Hard hardwoods	4,323
Soft hardwoods	2,102
Softwoods	360
All species	6,785

In sharp contrast to the 581 million cubic feet of net annual growth, the timber cut in 1954 was but 154 million cubic feet, and this cut tally included 24 million cubic feet in trees cut or killed by logging operators and left in the woods.

The ratio of growth to cut, in terms of cubic-foot volume, at first appears quite good. But, on closer inspection, it proves less favorable. For example, the net annual growth of sawtimber trees makes up a little more than one-

[9]The "hard" hardwoods are defined to include species having a hardness value of more than 80, as listed in table 1 of "Comparative Strength Properties of Woods Grown in the United States", U. S. Dept. Agr. Tech. Bul. 158, 1930.



All in all, Pennsylvania appears to be growing much more timber than is being cut; but the sawtimber trees are being cut heavily.

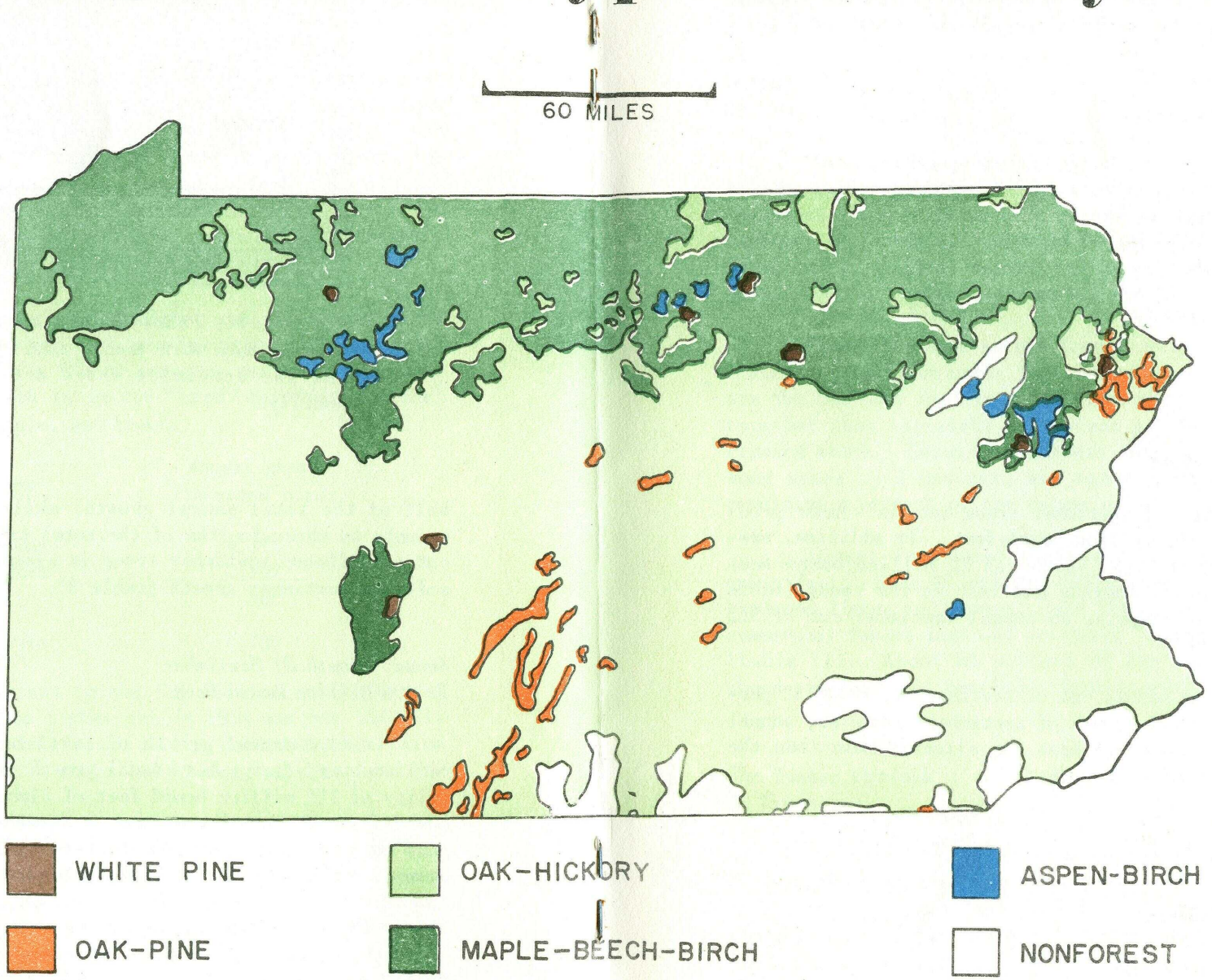
half of the total annual growth, while the sawtimber cut amounts to three-fourths of the total timber cut. The annual cut of softwood sawtimber trees is almost 90 percent of the softwood sawtimber growth (table 8).

Annual Growth Of Sawtimber Is 1.2 Billion Board-Feet

Gross annual growth of sawtimber adds up to 1,328 million board-feet. Net annual growth (after deducting mortality of 115 million board feet of timber) is 1,213 million board-feet. Softwood sawtimber ingrowth amounts to 40 percent of gross softwood growth; hardwood sawtimber ingrowth amounts to 51 percent of gross hardwood growth.

The net annual growth of sawtimber stands, including ingrowth, is about 230 board-feet per acre per year. If ingrowth is excluded, the net annual increase of sawtimber volume (in sawtimber stands) is about 105 board-feet per acre, or less than one-half of the total. Total growth in

The Major Forest Types in Pennsylvania



sawtimber stands would be 420 million board feet, which is less than the 1954 sawtimber cut of 513 million board-feet.

Hardwood species produce almost 93 percent of annual board-foot growth. The oaks alone account for 42 percent. All other hardwoods make up 51 percent of the total; and softwoods, principally hemlock, supply the remaining 7 percent:

Species group	*Annual growth (million bd-ft.)*
Oaks	505
Black cherry	115
Red maple	101
Other hardwoods	406
Softwoods	86
All species	1,213

Sawtimber Cut Amounts To 513 Million Board-Feet

Total volume of sawtimber trees cut for timber products in 1954 was 491 million board-feet. In addition, sawtimber trees with a total volume of 22 million board feet were cut or killed in logging and left in the woods (table 9). Together they comprise an annual sawtimber cut of 513 million board-feet.

Overall, the annual cut of sawtimber is about 42 percent of the net annual growth of sawtimber. However, annual cut of softwoods, in board-feet, is slightly more than the net annual growth of softwoods:

Species group	*Annual cut (million bd-ft.)*
Oaks	197
Black cherry	26
Red maple	17
Other hardwoods	181
Softwoods	92
All species	513

Much of the sawtimber cut is in larger diameter and better quality trees. Since about one-half of the board-foot growth is the volume of trees reaching minimum sawtimber size during the year, it appears that the larger and better sawtimber trees are being cut faster than they are being replaced through growth.

Output Of Timber Products

Total timber-products output in 1954 amounted to 195 million cubic feet, including 11 million cubic feet of plant residues. Nearly 90 percent of the products output was in sawlogs, fuelwood, and pulpwood (table 10). Round mine timbers, posts, piling, veneer and cooperage logs, and other miscellaneous products accounted for the remainder.

Timber-products output from growing stock was approximately 137 million cubic feet. Sawlogs and pulpwood bolts are the two most important timber products in Pennsylvania; together they represent 81 percent of the timber cut from growing stock. Round mine timbers make up 8 percent, fuelwood makes up 7 percent, and other products make up the remaining 4 percent of the volume cut from growing stock.

Output from other sources ran to about 58 million cubic feet. Some 47 million cubic feet of this material--hardwood limbs, cull trees, dead trees, and trees from noncommercial forest land and nonforest land--was used for fuel (table 11). About 83 percent of the fuelwood came from those sources; the remainder from growing stock.

The Timber Outlook Is Promising

In the twelve-state area of the Northeast, Pennsylvania ranks high as a timber-producer. It is second in area of commercial forest land, third in volume of standing sawtimber, and third in volume of timber products harvested in 1954.

Pennsylvania is also a major consumer of wood products. Currently its consumption of wood is four times its

production. Can the forests of Pennsylvania be managed to meet the ever-increasing demands of its expanding populace?

Timber stands in the state are comparatively young; their growth potential is high. Given efficient management and protection, the forests of Pennsylvania appear to be equal to the demand.

Appendix

Table 1.--Net volume of all timber on commercial forest land in Pennsylvania, by class of material and species group, 1955

Class of material	Softwoods	Hardwoods	Total
	Million cu. ft.	Million cu. ft.	Million cu. ft.
GROWING STOCK			
Sawtimber trees:			
Sawlog portion	626	4,174	4,800
Upper-stem portion	79	830	909
Total	705	5,004	5,709
Poletimber trees	296	6,106	6,402
Total growing stock	1,001	11,110	12,111
OTHER MATERIAL[1]			
Sound cull trees	60	856	916
Rotten cull trees	15	486	501
Hardwood limbs	--	1,120	1,120
Total other material	75	2,462	2,537
Total, all timber	1,076	13,572	14,648

[1]The item "salvable dead trees" is not included here because the volume of this class of material in Pennsylvania is insignificant.

Table 2.--Net volume of live sawtimber and growing stock on commercial forest land in Pennsylvania, by species, 1955

Species	Sawtimber	Growing stock
	Million bd.-ft.	Million cu. ft.
Softwoods:		
Hemlock	1,239	503
White pine	883	267
Pitch pine	359	150
Virginia pine	109	54
Other softwoods	24	27
Total	2,614	1,001
Hardwoods:		
Northern red oak	4,206	1,840
Other red oaks	975	376
Black cherry	2,062	989
Chestnut oak	1,941	1,336
White oak	1,898	911
Red maple	1,811	1,442
Beech	1,557	615
Sugar maple	1,406	978
Yellow-poplar	840	274
Basswood	713	300
Ash	681	398
Hickory	559	262
Sweet birch	401	349
Elm	316	144
Yellow birch	256	207
Aspen	123	406
Other hardwoods	461	283
Total	20,206	11,110
All species	22,820	12,111

Table 3.--Net volume of live sawtimber and growing stock on commercial forest land in Pennsylvania, by stand-size class and species group, 1955

Stand-size class and species group	Sawtimber	Growing stock
	Million bd. ft.	Million cu. ft.
Sawtimber stands		
Softwoods	1,797	599
Hardwoods	15,483	5,705
Total	17,280	6,304
Poletimber stands		
Softwoods	728	351
Hardwoods	4,280	5,030
Total	5,008	5,381
Other stands and other areas		
Softwoods	89	51
Hardwoods	443	375
Total[1]	532	426
All stands		
Softwoods	2,614	1,001
Hardwoods	20,206	11,110
Total	22,820	12,111

[1]Includes 33 million board-feet and 17 million cubic feet in nonstocked areas and other areas not elsewhere classified.

Table 4.--Net volume of live sawtimber on commercial forest land in Pennsylvania, by diameter-class group and species, 1955

(In millions of board-feet)

Species	Diameter-class group (in inches)						Total
	10	12	14	16	18	20	
Hemlock	247	283	256	137	112	204	1,239
White pine	144	159	123	122	85	250	883
Other softwoods	144	163	56	68	20	41	492
Total	535	605	435	327	217	495	2,614
Red oaks	--	1,016	1,244	895	670	1,356	5,181
Black cherry	--	778	595	414	182	93	2,062
Chestnut oak	--	569	502	363	229	278	1,941
White oak	--	457	379	332	198	532	1,898
Red maple	--	611	450	283	179	288	1,811
Beech	--	358	331	232	216	420	1,557
Sugar maple	--	339	272	140	123	532	1,406
Yellow-poplar and basswood	--	358	375	318	218	284	1,553
Other hardwoods	--	808	679	527	371	412	2,797
Total	--	5,294	4,827	3,504	2,386	4,195	20,206
All species	535	5,899	5,262	3,831	2,603	4,690	22,820

Table 5.--Quality of hardwood sawtimber on commercial forest land in Pennsylvania, by species, 1955

(In millions of board-feet)

Species	Standard-lumber logs			Tie and timber logs	Total
	Grade 1	Grade 2	Grade 3		
Red oaks	825	550	1,939	1,867	5,181
Black cherry	104	133	1,130	695	2,062
Chestnut oak[1]	86	140	1,084	631	1,941
White oak	183	325	791	599	1,898
Red maple	126	105	757	823	1,811
Beech	98	161	730	568	1,557
Sugar maple	263	166	518	459	1,406
Yellow-poplar and basswood	312	235	657	349	1,553
Other hardwoods	345	265	1,179	1,008	2,797
All hardwoods	2,342	2,080	8,785	6,999	20,206
Percent	12	10	43	35	100

[1]Worm holes no defect.

Table 6.--Net volume of live sawtimber and growing stock on commercial forest land in Pennsylvania, by ownership class, 1955

Ownership Class	Sawtimber	Growing stock
	Million bd.-ft.	Million cu. ft.
Public:		
National forest	465	346
Other Federal	31	26
State	1,529	1,560
County and municipal	156	111
Total	2,181	2,043
Private:		
Farm	3,532	1,934
Forest industry and other private	17,107	8,134
Total	20,639	10,068
All ownerships	22,820	12,111

Table 7.--Components of net annual growth of growing stock on commercial forest land in Pennsylvania, by species group, 1954

Components of net annual growth	Softwoods	Hardwoods	Total
	Million cu. ft.	Million cu. ft.	Million cu. ft.
Growth on growing stock	33	440	473
Ingrowth--saplings that became poletimber trees in 1954	11	193	204
Gross growth	44	633	677
Annual mortality	-15	-81	-96
Net annual growth	29	552	581

Table 8.--Annual cut and net annual growth of growing stock on commercial forest land in Pennsylvania, by tree-size class and species group, 1954

Tree-size class and species group	Annual timber cut[1]	Net growth
	Thousand cu.ft.	Thousand cu.ft.
Sawtimber trees:		
Softwoods	20,700	23,400
Hardwoods	93,500	281,300
Total	114,200	304,700
Poletimber trees:		
Softwoods	1,600	6,100
Hardwoods	38,400	270,500
Total	40,000	276,600

[1]Includes 24,000,000 cubic feet in logging residues.

Table 9.--Net annual growth, annual mortality, and annual cut of live sawtimber and growing stock on commercial forest land in Pennsylvania, by species group, 1954

Item	Sawtimber			Growing stock		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
	Million bd. ft.	Million bd. ft.	Million bd. ft.	Million cu. ft.	Million cu. ft.	Million cu. ft.
Net annual growth	86	1,127	1,213	29	552	581
Annual mortality	33	82	115	15	81	96
Annual cut						
Timber products	90	401	491	20	110	130
Logging residues	2	20	22	2	22	24
Total	92	421	513	22	132	154

Table 10.--Output of timber products and annual cut of live sawtimber and growing stock in Pennsylvania, 1954

Product	Output of timber products[1]					Annual cut of sawtimber			Annual cut of growing stock		
	Volume in standard units		Roundwood volume								
	Standard units	Number	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total
			M cubic feet			M board-feet			M cubic feet		
Sawlogs & veneer logs	M board-feet[2]	496,035	15,929	73,845	89,774	76,518	362,624	439,142	17,827	86,770	104,597
Cooperage	M board-feet	2,161	--	354	354	--	2,323	2,323	--	348	348
Pulpwood	Standard cords[3]	4/ 334,823	4,428	22,358	26,786	15,127	39,204	54,331	4,103	20,170	24,273
Fuelwood	Standard cords[3]	5/ 578,125	165	46,085	46,250	--	9,819	9,819	168	9,152	9,320
Piling	M linear feet	400	--	240	240	--	1,214	1,214	--	240	240
Posts	M pieces	9,979	190	5,985	6,175	--	3,718	3,718	182	3,766	3,948
Mine timbers	M cubic feet	11,624	--	11,624	11,624	--	571	571	---	9,555	9,555
Miscellaneous[6]	M cubic feet	7/ 2,743	--	2,743	2,743	--	2,061	2,061	--	1,790	1,790
Totals	--	--	20,712	163,234	183,946	91,645	421,534	513,179	22,280	131,791	154,071

[1]Includes material from growing stock and other miscellaneous sources.

[2]International ¼-inch rule.

[3]Standard cord, rough-wood basis.

[4]Does not include 1,903 cords (hemlock slabs) from plant residues.

[5]Does not include 39,075 cords softwood and 82,713 cords hardwood from plant residues.

[6]Includes chemical wood (2,723 M cubic feet hardwood growing stock), handles, baseball bats, shingles, and turnery products.

[7]Does not include 1,200 M cubic feet of mixed hardwood from plant residues, nor 10,000 tons of sulphate leacher residues (5,000 tons of activated charcoal produced from this leacher residue).

Table 11.--Source of timber-products output in Pennsylvania, 1954

Product	Timber products output		
	Source		Total[2]
	Growing stock	Other material[1]	
	Thousand cu.ft.	Thousand cu.ft.	Thousand cu.ft.
Sawlogs and veneer logs and bolts	85,701	4,043	89,744
Cooperage logs and bolts	348	6	354
Pulpwood	24,821	1,762	26,583
Fuelwood	9,250	37,000	46,250
Fence posts	3,915	2,260	6,175
Piling	240	--	240
Mine props	10,422	1,202	11,624
Other products[3]	2,144	599	2,743
All products	136,841	46,872	183,713

[1]Includes cull trees, hardwood limbs, dead trees, and trees from noncommercial forest and nonforest land.

[2]Does not include 11,095,000 cubic feet from plant residues.

[3]Includes chemical wood, handles, shingles, and turnery products.

Table 12.--Land area of Pennsylvania, by major classes of land, 1955

Class of land	Area	
	Thousand acres	Percent
Forest:		
Commercial	15,089	53
Noncommercial[1]	97	(2/)
Total	15,186	53
Nonforest[3]	13,643	47
Total all classes	28,829	100

[1]Includes 400 acres of unproductive forest land.

[2]Less than 1 percent.

[3]Includes 129,500 acres of water according to forest survey standards of area classification but defined by the Bureau of the Census as land.

Table 13.--Forest area and timber volume in Pennsylvania, by geographical section, 1955

Geographical section	Commercial forest area	Growing stock	Sawtimber
	Thousand acres	Million cu. ft.	Million bd.-ft.
Northwestern	977	801	1,718
Allegheny	2,706	2,668	5,465
North-central	2,540	2,444	3,481
Northeastern	1,825	1,295	2,070
Anthracite	1,144	502	658
Southeastern	1,298	1,076	2,628
South-central	2,417	1,852	3,583
Southwestern	2,182	1,473	3,217
Total	15,089	12,111	22,820

Table 14.--Land area and commercial forest-land area in Pennsylvania, by county, 1955

County	Land area	Commercial forest-land area		County	Land area	Commercial forest-land area	
	Acres	Acres	Percent		Acres	Acres	Percent
Adams	336,600	146,200	43	Lackawanna	290,600	186,900	64
Allegheny	467,200	129,000	28	Lancaster	604,800	91,700	15
Armstrong	422,400	170,700	40	Lawrence	234,900	50,300	21
Beaver	282,200	94,100	33	Lebanon	232,300	67,300	29
Bedford	651,500	388,700	60	Lehigh	222,100	57,300	26
Berks	553,000	175,500	32	Luzerne	570,200	387,200	68
Blair	339,800	192,300	57	Lycoming	777,600	561,400	72
Bradford	734,100	312,800	43	McKean	638,100	498,800	78
Bucks	394,900	111,900	28	Mercer	435,800	86,600	20
Butler	508,200	192,000	38	Mifflin	275,800	172,700	63
Cambria	444,800	259,000	58	Monroe	391,000	287,100	73
Cameron	256,600	243,600	95	Montgomery	314,900	62,000	20
Carbon	259,200	182,600	70	Montour	83,200	28,800	35
Centre	713,600	492,400	69	Northampton	239,400	49,600	21
Chester	486,400	116,700	24	Northumberland	290,600	93,400	32
Clarion	383,400	185,300	48	Perry	352,000	213,500	61
Clearfield	732,100	540,600	74	Pike	348,800	317,600	91
Clinton	577,300	509,000	88	Potter	698,900	559,100	80
Columbia	309,800	139,800	45	Schuylkill	501,100	312,100	62
Crawford	650,200	240,300	37	Snyder	210,600	126,200	60
Cumberland	355,200	109,700	31	Somerset	693,800	374,500	54
Dauphin	332,800	154,600	46	Sullivan	305,900	239,300	78
Delaware and Philadelphia	199,700	18,600	9	Susquehanna	535,000	264,800	50
Elk	517,800	456,100	88	Tioga	736,000	427,100	58
Erie	519,700	129,300	25	Union	203,500	109,000	54
Fayette	512,000	264,300	52	Venango	432,000	278,800	64
Forest	268,800	245,400	91	Warren	582,400	497,100	85
Franklin	482,600	184,700	38	Washington	548,500	122,800	22
Fulton	278,400	178,200	64	Wayne	476,200	309,500	65
Greene	369,300	115,500	31	Westmoreland	656,000	238,200	36
Huntingdon	572,100	404,700	71	Wyoming	253,400	146,500	58
Indiana	531,800	221,700	42	York	584,900	137,100	23
Jefferson	417,300	283,000	68				
Juniata	247,700	146,300	59	All	28,828,800	15,088,900	52

Table 15.--Commercial forest-land area in Pennsylvania, by ownership and stand-size classes, 1955

(In thousands of acres)

Ownership class	Saw-timber stands	Pole-timber stands	Seedling-and-sapling stands	Nonstocked and other areas[1]	Total area
Public:					
State[2]	216	1,920	508	15	2,659
National forest[3]	96	295	57	8	456
Other public[4]	31	101	52	7	191
Total	343	2,316	617	30	3,306
Private[5]	3,690	4,835	2,799	459	11,783
All ownerships	4,033	7,151	3,416	489	15,089

[1]Includes areas not classified elsewhere.

[2]State ownership as of January 1, 1955.

[3]National forest ownership as of June 30, 1956.

[4]Includes 156,000 acres of county and municipal forest land and 35,000 acres of Federally-owned forest land.

[5]Includes 3,248,000 acres of farm woodland, 442,000 acres of forest land owned by forest industry, and 8,093,000 acres of forest land owned by "other private" class of ownership.

Table 16.--Area of commercial forest land in Pennsylvania, by major forest-type group, 1955

Forest type[1]	Area	
	Thousand acres	Percent
White pine:		
White pine	157	1
White pine-hardwood	67	(2/)
Total	224	1
Oak-pine:		
Pitch and Virginia pine	210	1
Yellow pine-oak	153	1
Oak-pitch pine	81	1
Total	444	3
Oak-hickory:		
Red oak	5,107	34
Chestnut oak	2,262	15
White oak	1,099	7
Scrub oak[3]	97	1
Yellow-poplar	128	1
Oak-white pine	95	1
Eastern redcedar	47	(2/)
Total	8,835	59
Northern hardwood:		
Sugar maple-beech-yellow birch	3,869	26
Red maple	252	2
Hemlock	305	2
Bottomland hardwoods	55	(2/)
Northern hardwood-white pine	27	(2/)
Total	4,508	30
Aspen-birch:		
Aspen-gray birch-pin cherry	1,065	7
Paper birch	13	(2/)
Total	1,078	7
All forest types	15,089	100

[1]Local forest types have been grouped to facilitate summarizing major forest-type groups by states.

[2]Less than 1 percent.

[3]Acreage in scrub oak is much smaller than that reported in a 1951 bulletin by the Pennsylvania Department of Forests and Waters. The difference probably can be attributed to the much less intensive sampling on the Forest Survey.

DEFINITIONS OF TERMS

Forest Area

Forest-land area.--Includes: (a) lands that are at least 10 percent stocked with trees of any size and are capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking and that has not been developed for other use; and (c) afforested areas. (Forest tracts of less than 1 acre, isolated strips of timber less than 120 feet wide, and abandoned fields and pastures not yet 10 percent stocked with trees are excluded.)

Commercial forest-land area.--Forest land that is (a) producing, or physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; and (c) not withdrawn from timber utilization through statute, ordinance, or administrative order.

Noncommercial forest-land area.--Forest land (a) withdrawn from timber utilization through statute, ordinance, or administrative order, but that otherwise qualifies as commercial forest land; or (b) incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions, or so physically inaccessible as to be unavailable economically in the foreseeable future.

Forest Cover Types

The forest cover types are classified according to the predominant species or species group, as indicated by cubic volume for sawtimber and poletimber stands, and number of trees for seedling-and-sapling stands. All local types are keyed to certain major forest types (table 16) to facilitate combining the Pennsylvania estimates with estimates made in other states.

White pine.--Forests in which 50 percent or more of the stand is eastern white pine. (Common associates include hemlock, aspen, birch, and maple.) This major type includes the local forest-cover types: white pine and white pine-hardwood.

Oak-pine.--Forests in which 25 percent or more of the stand is pitch pine or Virginia pine. (Common associates include oak, hickory, and blackgum.) Local forest-cover types are pitch and Virginia pine, yellow pine-oak, and oak-pitch pine.

Oak-hickory.--Forests in which 50 percent or more of the stand is in the oak species, singly or in combination. (Common associates include yellow-poplar, elm, maple, and black walnut.) This major type includes the local forest-cover types: Red oak, chestnut oak, white oak, scrub oak, yellow-poplar, oak-white pine, and Eastern redcedar.

Northern hardwood.--Forests in which 50 percent or more of the stand is sugar maple, beech, or yellow birch, singly or in combination. (Common associates include hemlock, elm, basswood, red maple, black cherry, and white pine.) Local forest-cover types include sugar maple-beech-yellow birch, red maple, hemlock, bottomland hardwoods, and northern hardwood-white pine.

Aspen-birch.--Forests in which 50 percent or more of the stand is aspen, paper birch, gray birch, or pin cherry singly or in combination. (Common associates include red maple and balsam fir.) This major type includes the local types: Aspen-pin cherry, aspen-gray birch-pin cherry, and the paper birch.

Class of Timber

Sawtimber trees.--Trees of commercial species that contain at least one merchantable sawlog as defined by regional practice and that are of the following minimum diameters at breast height: softwoods 9.0 inches and hardwoods 11.0 inches. (A merchantable sawlog is a portion of a live tree that meets the minimum log-grade specifications, as defined under log-grade classification.)

Poletimber trees.--Trees of commercial species that meet regional specifications of soundness and form, and are of the following diameters at breast height: softwoods 5.0 to 9.0 inches; hardwoods 5.0 to 11.0 inches. (Such trees will usually become sawtimber trees if left to grow.)

Seedling-and-sapling trees.--Live trees of commercial species less than 5.0 inches in diameter at breast height and of good form and vigor.

Cull trees.--Live trees of sawtimber or poletimber size that are unmerchantable for sawlogs now or prospectively because of defect or rot, or because they are of undesirable species.

Hardwood limbs.--Limbs of hardwood sawtimber trees and sawtimber-size cull hardwood trees to a minimum diameter of 4.0 inches inside bark.

Stand-Size Classes

Sawtimber stands.--Stands with sawtimber trees having a minimum net volume per acre of 1,500 board-feet, International ¼-inch rule.

Poletimber stands.--Stands failing to meet the sawtimber stand specification, but at least 10 percent stocked with poletimber and larger trees (5.0 inches d.b.h. and larger), and with at least half of the minimum stocking in poletimber trees. (Poletimber stands carry at least 200 cubic feet per acre.)

Seedling-and-sapling stands.--Stands not qualifying as either sawtimber or poletimber stands, but having at least 10 percent stocking of trees of commercial species, and with at least half the minimum stocking in seedling-and-sapling trees.

Nonstocked and other areas not elsewhere classified.--Areas that do not qualify as sawtimber, poletimber, or seedling-and-sapling stands; areas less than 10 percent stocked with trees of commercial species.

Timber Volume

Growing stock.--Net volume, in cubic feet, of live sawtimber trees and live poletimber trees from stump to a minimum 4-inch top (of central stem) inside bark. (Net volume = Gross volume less deductions for rot.)

Live sawtimber volume.--Net volume in board feet, International ¼-inch rule, of merchantable sawlogs in live sawtimber trees of commercial species. (Net volume: Gross volume in terms of the International ¼-inch log rule less deductions for rot, sweep, and other defects affecting use for lumber.)

Standard cord.--A unit of measure for stacked wood, encompassing 128 cubic feet of wood, bark, and air space. Cord estimates are derived from cubic-foot measurements by applying a factor of 80 cubic feet of wood (inside bark) per rough cord.

Log Grades

The log grades used in the forest survey of Pennsylvania are outlined in the figures on pages 38, 39, 40, and 41.

Pulpwood Suitability

The pulpwood specifications used in this report are those set up by the Appalachian Technical Committee of the American Pulpwood Association.

Pulpwood Trees

Live trees of commercial species, 5.0 inches d.b.h. and larger, containing at least two contiguous pulpwood bolts and with 50 percent or more of the main-stem volume usable for pulpwood. (A pulpwood bolt is a section of the main stem 4 feet long; 4.0 inches or larger inside bark at the small end; free from any indication of rot, charred wood, metal, or hollow center; and contiguous to one or more other bolts that meet the same requirements. Crotches are excluded; sweep or crook

HARDWOOD LUMBER LOGS

The grade standards used for hardwood lumber logs in the forest survey of Pennsylvania.

GRADE FACTORS*		SPECIFICATIONS							
		Log Grade 1			Log Grade 2				Log Grade 3
Position in tree		Butts only	Butts & uppers		Butts & uppers				Butts & uppers
Minimum diameter (inches)		[1]13-15	16-19	20+	[2]11	12+			8+
Minimum length (feet)		10+	10+	10+	10+	8-9	10-11	12+	8+
Clear cuttings** on each of the 3 best faces	Min. length (feet)	7	5	3	3	3	3	3	2
	Max. number	2	2	2	2	2	2	3	--
	Min. yield in face length	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Max. sweep and crook allowance (percent of gross volume)		15			30				50
Max. cull and sweep allowance (percent of gross volume)		[3]40			[4]50				50

*End defects, although not visible in standing trees, are important in grading cut logs. Instructions for dealing with this factor are contained in Forest Prod. Lab. Rpt. D1737.

**A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth the surface of the log as divided lengthwise.

[1]Ash and basswood butts can be 12 inches if otherwise meeting requirements for small No. 1's.

[2]10-inch logs of all species can be No. 2 if otherwise meeting requirements for small No. 1's.

[3]Otherwise No. 1 logs with 51-60 percent cull can be No. 2.

[4]Otherwise No. 2 logs with 51-60 percent cull can be No. 3.

TIE AND TIMBER LOGS

GRADE FACTORS		SPECIFICATIONS
Position in tree		Butts and uppers
Scaling diameter (inches)		8+
Length, without trim (feet)		8+
Clear cuttings		No requirements: not graded on cutting basis.
Max. sweep allowance		One-fourth d.i.b. of small end for half logs, and one-half d.i.b. for logs 16 feet long.
Sound surface defects permitted	Single knots	Any number, if none has an average collar* diameter that is more than one-third of log diameter at point of occurrence
	Whorled knots	Any number, provided the sum of the collar diameters does not exceed one-third the log diameter at point of occurrence.
	Holes	Any number not exceeding knot specifications if they do not extend more than 3 inches into the contained tie or timber.
Unsound surface defects** permitted	Any number and size if they do not extend into contained tie or timber. If they extend into contained tie or timber, they shall not exceed size, number, and depth of limits for sound defects.	

*Knot collar is the average of the vertical and horizontal diameters of the limb or knot swelling as measured flush with the surface of the log.

**Interior defects are not visible in standing trees. They are considered in grading cut logs. No interior defects are permitted except one shake not more than one-third the width of the contained tie or timber, and one split not more than 5 inches long.

The grade standards used for hardwood tie and timber logs in the forest survey of Pennsylvania.

WHITE PINE LOG GRADES

GRADE	DIAMETER inside bark, small end *(inches)*	LENGTH without trim *(feet)*	TOTAL DEDUCTION PERMITTED[1] *(percent)*	SURFACE REQUIREMENTS
1	13+	8	0	Surface clear 100%
	13-16	12-16	25	Must be 2/3 surface-clear in lengths 8 feet long or longer or 50% surface-clear full length.
	17+	10-16	30	Must be 1/2 surface-clear in lengths 8 feet long or longer or 25% surface-clear full length.
2	9-16	10-16	30	Permits sound, tight knots not over 2½ inches in diameter. Larger, sound, tight knots permitted only if 50% of full-length surface has no sound, tight knots larger than 2 inches in diameter.
	17+	8-16	40	Permits sound, tight knots not over 3 inches in diameter. Larger, sound, tight knots permitted only if 50% of full-length surface has no sound, tight knots larger than 2½ inches in diameter.
3	6-7	8-16	25	Permits sound knots not over 1 inch in diameter or live knots not over 2 inches in diameter.
	8-13	8-16	30	No surface requirements except logs with knots 4 inches or more in diameter in whorls less than 2 feet apart will not be accepted unless 15% or more of full length surface has no sound knots over 2 inches in diameter.
	14+	8-16	40	No surface requirements except that knots over 6 inches in diameter cannot be closer than 3 feet.

[1] Includes sweep, rot, and other cull.

The grade standards used for white pine logs in the forest survey of Pennsylvania.

YELLOW PINE LOGS

GRADE	DIAMETER (in inches, inside bark)	LENGTH (feet)	SURFACE REQUIREMENTS
1	10-16	8+	Surface clear (not considering adventitious knots or branches).
	16+	8+	Not more than three 2- to 4-inch knots and any number of smaller knots.
2	8-9	8+	Surface clear.
	10-13	8+	Any number of small knots (less than 2 inches in diameter).
	14+	8+	Not more than six 2- to 4-inch knots and any number of smaller knots.
3	6-7	8+	Any number of small knots not exceeding 1-inch in diameter.
	8-13	8+	Not more than six 2- to 4-inch knots and any number of smaller knots.
	14+	8+	More than six 2- to 4-inch knots. Any log with one or more knots 5 inches or larger.
	Knotty or crooked merchantable logs 8 inches d.i.b. or larger and 10 feet in length or longer that do not fall in either Grade 1 or Grade 2.		

The grade standards used for yellow pine logs in the forest survey of Pennsylvania.

in any section shall exclude the bolt if a line from center of top cut to center of bottom cut passes outside the wood at any point.)

Pulpwood Stands

0 to 5 cords per acre.--Stands containing trees 5.0 inches d.b.h. and larger that meet pulpwood specifications, and having a net volume per acre of less than 400 cubic feet. (Includes light poletimber stands, seedling-and-sapling stands, and nonstocked areas.)

5 to 15 cords per acre.--Stands containing trees 5.0 inches (d.b.h.) and larger that meet pulpwood specifications, and having a net volume per acre ranging from 400 to 1,200 cubic feet.

15 cords or more per acre.--Stands containing trees 5.0 inches (d.b.h.) and larger that meet pulpwood specifications, and having a net volume per acre of more than 1,200 cubic feet.

Pulpwood Volume

Net volume in standard cords (including bark) of the main stems of pulpwood trees, from stump to point where the top breaks up into branches or to a minimum top diameter of 4.0 inches (inside bark). Deductions are made for all portions of the stem that fail to meet pulpwood bolt requirements.

Growth And Annual Cut

Net annual growth of sawtimber.--The change (resulting from natural causes) in net board-foot volume of live sawtimber on commercial forest land during a specified year.

Ingrowth of sawtimber.--The net board-foot volume of trees that first became sawtimber trees during the inventory year as measured at the end of the year.

Annual mortality of sawtimber.--The net board-foot volume removed from live sawtimber on commercial forest land during a specified year through death from natural causes.

Net annual growth of growing stock.--The change (resulting from natural causes) in net cubic-foot volume of growing stock on commercial forest land during a specified year.

Ingrowth of growing stock.--The total net cubic-foot volume of trees that first become a part of growing stock during the inventory year as measured at the end of the year.

Annual mortality of growing stock.--The net cubic-foot volume removed from growing stock during a specified year through death from

natural causes.

Annual cut of live sawtimber.--The net board-foot volume of live sawtimber trees cut or killed by logging, and by land-clearing and cultural operations, on commercial forest land during a specified year.

Annual cut of growing stock.--The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging, and by land-clearing and cultural operations, on commercial forest land during a specified year.

FOREST SURVEY METHODS

Estimates of forest area, timber volume, and growth reported here are based upon information obtained from aerial photographs and from sample plots examined on the ground. First, photo-interpretation plots were marked off on aerial photographs. These plots were distributed uniformly by mechanical means over photographs of the entire State. Each photo plot was then classified as either forest or non-forest. Forest plots were classified further according to stand size and broad forest type.

Field crews inspected some of the photo plots on the ground. Enough plots were selected at random to attain specified levels of statistical accuracy. Species and volume data were collected on these ground plots; and the photo classification of stand size and forest type was verified or--if necessary--changed.

Growth was computed from measurements of radial growth and inventory data on numbers of trees by species and diameter class, after adjusting for cutting and expected mortality. Radial growth was measured on increment cores extracted from sample trees. The final estimate was of average annual periodic net growth at the time the inventory was made.

Estimates of timber cut in Pennsylvania were based on production surveys and wood-utilization studies conducted by the Northeastern Forest Experiment Station. The production surveys yielded estimates of the output of all timber products. From studies conducted on all types of logging operations, estimates of logging residues were developed, which, when added to the volume of timber products, gave estimates of timber cut.

RELIABILITY OF THE ESTIMATES

The estimates in this report may contain two kinds of errors. First, photo-interpreters may make mistakes in classification and fieldmen may make mistakes in measuring and recording. While there is no practical way of finding out just how often such errors occur, they are kept to a minimum by closely checking all phases of the work.

The second kind of error is inherent in sampling procedures. The size of this sampling error can be measured. If there are no errors of the first kind, the probabilities are two out of three that actual areas and volumes do not vary from the estimates by more than shown.

Commercial forest-land area.--The sampling intensity of the survey completed in 1954 provided an estimate of the total forest area in Pennsylvania with a standard error of ± 0.8 percent. The standard error per million acres is ± 3.2 percent.

Cubic-foot volume.--The standard error of the net cubic-foot volume inventory estimate is ± 1.6 percent.

Board-foot volume.--The standard error of the total board-foot volume inventory estimate is ± 2.7 percent.

Net annual growth of growing stock.--The standard error of the cubic-foot growth estimate is ± 5.4 percent.

Annual cut of growing stock.--The standard error of the cubic-foot cut estimate is ± 11.0 percent.

In each of the tables, the total figures are more reliable than the subtotals, and the subtotals are more reliable than any of their component figures. Figures that are small in relation to totals are subject to larger sampling errors. The actual range of errors for county data is as follows:

	Percent of error	
	Low	*High*
Commercial-forest area	1.0	25
Growing-stock volume	7.6	22
Board-foot volume	11.5	40

SPECIES TALLIED

The various tree species tallied[10] in Pennsylvania are listed below in the same order as table 2.

Commercial Softwood Species

Eastern hemlock	- *Tsuga canadensis*
White pine (Eastern white pine)	- *Pinus strobus*
Red pine	- *Pinus resinosa*
Pitch pine	- *Pinus rigida*
Virginia pine	- *Pinus virginiana*
Other eastern softwoods:	
Spruce	- *Picea* species
Tamarack	- *Larix laricina*
Eastern redcedar	- *Juniperus virginiana*
Northern white-cedar	- *Thuja occidentalis*

Commercial Hardwood Species

Northern red oak	- *Quercus rubra*
Other red oaks:	
Black oak	- *Qurecus velutina*
Scarlet oak	- *Quercus coccinea*
Pin oak	- *Quercus palustris*
Willow oak	- *Quercus phellos*
Black cherry	- *Prunus serotina*
Chestnut oak	- *Quercus prinus*
White oak	- *Quercus alba*
Red maple	- *Acer rubrum*
American beech	- *Fagus grandifolia*
Sugar maple	- *Acer saccharum*
Yellow-poplar	- *Liriodendron tulipifera*
American basswood	- *Tilia americana*
Ash	- *Fraxinus* species
Hickory	- *Carya* species
Sweet birch	- *Betula lenta*
Elm	- *Ulmus* species
Yellow birch	- *Betula alleghaniensis*
Aspen	- *Populus* species
Other eastern hardwoods:	
Black locust	- *Robinia pseudoacacia*
Cucumbertree	- *Magnolia acuminata*
Sweetgum	- *Liquidambar styraciflua*
Black walnut	- *Juglans nigra*

[10] Little, Elbert L., Jr. Check list of native and naturalized trees of the United States (including Alaska). U. S. Dept. Agr., Agr. Handb. 41. 472 pp. 1953.

Blackgum	- *Nyssa sylvatica*
Butternut	- *Juglans cinerea*
Bur oak	- *Quercus macrocarpa*
Yellow buckeye	- *Aesculus octandra*
Swamp white oak	- *Quercus bicolor*
American sycamore	- *Platanus occidentalis*
Paper birch	- *Betula papyrifera*
Willow	- *Salix* species
Flowering dogwood	- *Cornus florida*

Noncommercial Species

American hornbeam	- *Carpinus caroliniana*
Downy serviceberry	- *Amelanchier arborea*
Eastern hophornbeam	- *Ostrya virginiana*
Gray birch	- *Betula populifolia*
Pin cherry	- *Prunus pensylvanica*
Sassafras	- *Sassafras albidum*

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